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(54) Title: SYSTEM AND METHOD OF SUPPLY CHAIN MANAGEMENT

(57) Abstract: A supply chain management system and method for managing a supply chain that enables a user to analyze and control numerous aspects of the supply chain including up-stream supplier capabilities and constraints, and down-stream customer needs and constraints. The system applies data warehouse design concepts to the Supply Chain Operations Reference (SCOR) model processes developed by the Supply Chain Council (SCC). The supply chain management system permits vertical integration of order management, vendor managed inventory, transportation management, and legacy transaction systems. The system consolidates transaction history across multiple, disparate systems to allow query and analysis of business key indicators and metrics, and can help to closely track supply verses demand.

SYSTEM AND METHOD OF SUPPLY CHAIN MANAGEMENT

1. BACKGROUND OF THE INVENTION

1.1 FIELD OF THE INVENTION

The present invention relates to a supply chain management system and method therefor. More particularly, the present invention relates to system and method for managing a supply chain that enables a user to analyze and control numerous aspects of the supply chain including up-stream supplier capabilities and constraints, and down-stream customer needs and constraints. The system applies data warehouse design concepts to the Supply Chain Operations Reference (SCOR) model processes developed by the Supply Chain Council (SCC).

1.2. DESCRIPTION OF THE PRIOR ART

At present, there is no convenient way for a business to analyze and/or quickly and easily manage its supply chain, be it in an upstream or downstream direction. The number of factors affecting the supply chain makes such management an arduous task, at best. For example, the cost of raw materials, the cost of transportation, labor costs, market considerations, customer demands, product changes, inventory stocks, and accounts receivable and payable are just some of the factors that need to be accounted for.

In addition entities making up the supply chain operate with different management and accounting systems, and are not necessarily inclined to making their internal data public. As a result, there is no simple method for providing management of the supply chain that works across multiple platforms.

The Supply Chain Council (SCC) was formed in the late 1990's as a grass roots initiative to model the entire supply chain and all of its processes. The SCC produced the Supply Chain Operations Reference (SCOR) model processes as a result of this initiative. However, the various methods of accessing data, from and about the supply chain components, do not make use of the SCOR model, and are often manual or stovepipe, requiring complex extraction from various enterprise legacy systems. Such methods often are without meaningful decision support capabilities.

2. SUMMARY OF THE INVENTION

These and other deficiencies of the prior art are addressed by the present invention that is directed to a supply chain management system and method therefor.

The present invention applies data warehouse design concepts to supply chain operation model processes, thus permitting vertical integration of order management, vendor managed inventory, transportation management, and legacy transaction systems. The system consolidates transaction history across multiple, disparate systems to allow query and analysis of business key indicators and metrics.

The present invention can help to closely track supply verses demand when, for instance, a business has an excessive amount of inventory in its warehouse. The system of the present invention can be used to analyze current business practices and needs, and determine how an organization compares to the Supply-Chain Council's list of best practices. The system can further be used to recommend modifications to improve the business, and to help implement these changes.

The present supply chain management system provides a supportive process that will assist the client team in documenting a supply chain vision that supports the strategic business strategy. The system can assist in the definition of the supply chain processes required to execute the strategy, and establish the organizational issues and requirements to execute the processes to meet the strategy. In addition, the system facilitates collaborative process and organizational interaction required to support the vision and strategy.

Other benefits include the ability to determine the information requirements for the process and organizational elements, and to determine the technology requirements to deliver the information and environment for collaborative participation. The system will then be able to document the final "To Be" system required to support the vision and strategy in terms of process, organization and technology. In summary, the supply chain management system can provide: a supply chain vision, mission, and process definition; a supply chain metrics and targets, organizational specifications for successful execution; and information and technology specifications for successful execution.

The supply chain management system of the present invention provides the following capabilities:

Evaluate a company's current business model;

Determine a company's requirements, and evaluate the commercial-off-the-shelf (COTS) tools needed to achieve these requirements;

Use the Supply-Chain Council's list of best practices, analyze the current business metrics and a determine what metrics should be tracked in the future;

Perform Business Process Reengineering (BPR) functions, if required;

Analyze industry trends as they relate the company's business;

Develop processes and work flows; and

Determine the gap between the company's current business practice and the desired result.

The supply chain management system of the present invention can document the organizational net assessment, including the associated deliverables, namely organizational net assessment, documented business performance requirements, team cast portrayal of the supply chain, and documented gaps from supply chain model.

From the foregoing, it is an object of the present invention to provide a supply chain management system that establishes available industry benchmarks, and establishes the meaning of success for a business.

Another object of the supply chain management system according to the present invention is to establish the degree of supply chain maturity of an organization.

Yet another object of the supply chain management system according to the present invention is to establish the scope of supply chain performance required of an organization, and establish the baseline for current performance within the supply chain; identify extremes.

Still another object of the supply chain management system according to the present invention is to analyze organization and structure, quality and measurement, operations management, information and technology, customer and external relationships, and knowledge and its use.

Another object of the supply chain management system according to the present invention is to team cast for roles within the organization, supply side participants and demand side participants; identify decision authorities and decision methods.

3. BRIEF DESCRIPTION OF THE DRAWINGS

These and other attributes of the present invention will be described with respect to the following drawings in which:

FIG. 1 is a block diagram of Business Integration and Decision Support Architecture;

FIG. 2 is a diagram of a methodology for ensuring that the business needs are understood, and that the strategy is expressed in business processes, the business organization, and then the supporting technology for those two elements;

FIG. 3 is a chart illustrating the flow of information according to the supply chain management system of the present invention;

FIG. 4 is a flow diagram of order management process functions of the present invention;

FIG. 5 is a flow diagram of the warehouse management process of the present invention;

FIG. 6 is a flow diagram of the product monitoring process of the present invention;

FIG. 7 is a diagram of the transportation management process of the present invention;

FIG. 8 is a graphical representation of the data warehouse/marts infrastructure according to the present invention;

FIG. 9 is a graphical representation of an N-Tier network/server architecture according to the present invention;

FIG. 10 is a graphical representation of the a base view of the supply chain according to the present invention;

FIG. 11 is a graphical representation of a meta view of the supply chain management according to the present invention;

FIG. 12 is a graphical representation of a meta view of the supply chain measurement according to the present invention; and

FIG. 13 is a flow chart of integrated logistics for the supply chain management system according to the present invention;

FIG. 14 illustrates a user interface login screen according to the present invention;

FIG. 15 illustrates a system main menu screen according to the present invention;

FIG. 16 illustrates an SCM operation management system menu according to the present invention; and

FIGS. 17 and 18 illustrate an accounts payable screen and an accounts receivable screen, respectively, according to the present invention.

4. DETAILED DESCRIPTION OF THE INVENTION

The present invention can help to closely track supply verses demand when, for instance, a business has an excessive amount of inventory in its warehouse. The system of the present invention can be used to analyze current business practices and needs, and determine how an organization compares to the Supply-Chain Council's list of best practices. The system can further be used to recommend modifications to improve the business, and to help implement these changes.

The primary functions of the supply chain management system of the present invention include the ability to extract data from legacy systems using automated programming interfaces, message queuing, and processware, the ability to populate an operational data store with enterprise views of existing legacy data, the ability to map the enterprise operational data store and business processes to the SCOR model, and the ability to apply OracleTM data warehouse techniques and tools to an analysis and management of key performance indicators and metrics.

The supply chain management system solution set allows application of the SCOR model to any business requiring advanced supply chain management analysis capability. The data warehouse is structured generally to allow mapping of virtually any legacy transaction system or set of systems, through an operational data store and enterprise view of legacy data and business processes, directly to the processes contained within the SCOR model.

As a result, the system provides for the development of a multi-tier, decision support infrastructure capability integrated with back office functions. The system allows for the application of supply chain information mining and knowledge management. Automated messaging and alerts may be initiated when supply chain performance or events deviate from expectations and preset metrics. Further, the system facilitates vertical integration of legacy applications or ERP transaction systems without modifying the underlying systems.

Using the SCOR model as the basis for mapping processes and measuring performance against established benchmarks allows for decision support against best-of-class criteria. Further, the application of the SCOR model within a solid data warehouse framework allows rapid and dynamic implementation in almost any environment or business model. The extract, transform and transport (ETT) methodology used in the solution set allows mapping of legacy data from any source to the generic data warehouse. The business scenario templates modeled in the design repository, supporting the solution set, provide for rapid mapping and modeling of business problems and requirements to the underlying models and architecture. The enterprise visibility components of the solution set provide flexible and scalable decision support capability across multiple, disparate legacy applications and transaction systems without requiring extensive and costly modifications to the underlying systems. All of the foregoing aspects are leveraged in one solution set that is generic enough to apply across large spectrums of supply chain disciplines.

The management system can: provide a supportive process that will assist the client team in documenting a supply chain vision that supports the strategic business strategy; assist in the definition of the supply chain processes required to execute the strategy; establish the organizational issues and requirements to execute the processes to meet the strategy; facilitate collaborative process and organizational interaction required to support the vision and strategy; determine the information requirements for the process and organizational elements; determine the technology requirements to deliver the information and environment for collaborative participation; and document the final "To Be" system required to support the vision and strategy in terms of process, organization and technology

The supply chain management system of the present invention provides:

The ability to evaluate a company's current business model;

The ability to determine a company's requirements, and evaluate the commercial-off-the-shelf (COTS) tools needed to achieve these requirements;

The ability to use the Supply-Chain Council's list of best practices, analyze the current business metrics and a determine what metrics should be tracked in the future;

The capability to perform Business Process Reengineering (BPR) functions, if required;

The ability to analyze industry trends as they relate the company's business;

The ability to develop processes and work flows; and

The ability to determine the gap between the company's current business practice and the desired result.

The supply chain management system of present invention provides the dynamic capability of integrating information across multiple applications and enterprises into a system for inter-enterprise decision support.

The system supports multiple applications that provide executive information from a logistics business domain. Through supply chain management, the logistics business domain encompasses most business critical systems and extensions beyond a single enterprise to all participants in business so that they can achieve success through their supply chain performance.

Vertical integration is the modeling of the business processes and decisions as well as other key factors in a dynamic repository so they can be used to provide access to real data, and to adjust rapidly when the business changes, without impacting the transaction systems in use. The actual transaction systems are not physically integrated (horizontal integration) at the transaction level. A business transaction can be analyzed within the business rules, which leads to the generation of applicable Electronic Data Interchange "EDI" transaction messages that update the appropriate transaction systems of record.

A Business Integration and Decision Support (BIDS) environment has many components, as shown in Figure 1.

Query analysis and data mining OLAP tools, shown in block 50 are normally strap-on tools that allow one to design specific queries, as a user, to build views into information. The richer the information, the better comparisons can be made with the tools 50. The user must have

access to the information and have some training if pre-defined queries are not provided to support the business needs. The unique queries and the graphics are configured to display meaningful information. Data Mining (looking through large volumes of information across multiple domains) is an ultimate use of this capability. OLAP capability normally requires modeling the business decisions and key performance indicators as a means to understand what queries are needed to support the business. The result is generally easy to read graphics about competitiveness, profitability, marketing comparisons, etc.

Without already defined key performance indicators and business processes, this activity could be lengthy and often is described as Business Process Reengineering if done from scratch.

In order to present the routine business process requirements, most applications build screens or windows to allow individuals to obtain the information tailored to their job and required workflow. These screens are constructed from standard coding practices, or from assembling pieces from repositories or libraries (more current practice). It is uncommon to develop web capability for these systems since most development environments have the tools necessary to make any screen you develop into a web accessible page. To develop these screens, it is necessary to understand the business processes that one's screens will support.

When libraries are used to build the screens, the savings in time and dollars can be up to five times what it would take without the libraries available. Without the business processes described, this initial activity could also be lengthy.

The information directory 52 is the navigation mechanism for the data warehouse 54. It includes levels of relationships that tie data dictionary information to the business processes and data-flows. The directory 52 is used to navigate through legacy or other transaction systems 56 to obtain the right piece of data to bring to the data warehouse database 54 for use in the decision support systems that are presented to the user. The capability allows you to define what your business will call certain data elements and to give you the capability to use your definitions to navigate to and select data from multiple other systems. Without the defined business processes, the relationships between the data and the processes, and the internal navigation to work-flow screens, the development of a means 58 to tie the data to the business processes would require at least 36% of one's total development effort. Changes can be expected for each new similar

business domain (stay within the supply chain area) with great savings (average of 80% already done).

There are levels of databases in a data warehouse. The lowest level is called an operational data store 60. It is a physical database that is constructed to represent a business at a given point in time. There are also logical databases that are multi-dimensional to capture the nuances of particular business segments such as marketing, purchasing, accounting, transportation, etc. (with the third dimension often being time). Each of these multi-dimensional "cubes" must have relationships described to manage the way that populating the databases would occur. Marts 62 and Enterprise Data Warehouses 64 fall into this category.

Without the business processes being fully developed, there is no certainty that all of the data required to support the business would be represented in the databases. Once the databases are developed and applications are built to use them it becomes much harder to retrofit changes to the databases. Therefore, the business processes need to be well developed to minimize retrofitting time.

This component of data warehouses/marts 62 and 64 is the actual capability to go and get data elements from multiple systems, clean the data to user standards, transform the data to the format required within the warehouse/mart, and commit it to the warehouse or mart in a usable form.

There are significant tools available to perform this function. The use of the tools is empowered significantly from having the information directory in a dynamic form; otherwise the descriptions and configurations of the tools would be lengthy to ensure that the data is coming across correctly.

There are many forms of electronic commerce (EC) and security has similarly many types of application. Many tools come with the capability to handle EC and to configure security environments. In custom coded applications there are protocols and standards to meet to build features that can provide the EC and security capabilities. Also, it is not uncommon lately to see these features built into production environments through an integrated suite of tools. EC is more commonly applied to transaction systems, but information may also be pertinent to the decision support systems. Security is required for both domains and multiple layers are common to ensure

not only access to what the user needs, but also protection from access by those who should not have access.

The environment readiness for these features is critical to not having to develop these applications since such development could be lengthy and less tested.

The supply chain management system of the present invention provides for secure web access to information with controlled access to participants that need total assurance that their competitive data is not accessible by other participants in the system. A preferred embodiment in the environment deals with supply chain processes; similar capabilities exist for business specific needs. The environment is a technical solution to a particular domain. Achieving the technical solution requires a methodology to ensure that the business needs are understood, and that the strategy is expressed in business processes, the business organization, and then the supporting technology for those two elements. Figure 1 identifies the methodology used to define the parameters for the technical solution.

Referring to Fig. 1, data from the existing ERP and operational systems 56 is acquired through the ETT 58. The data manager 66 and the information directory 52 receive data from the ETT 58. The information directory 52 is accessed through design tools and data warehouse/marts builder 68. The query analysis and mining tools 50 utilize the information from the data manger 66. Information creation and delivery 70 utilizes information from both the data manager 66 and the information directory 52. The information produced in the information directory 52 is stored in the repository database 72. The results of the information creation are displayed through a user interface 74.

The methodology of supply chain management system according to the present invention allows a business to be modeled incrementally with the enterprise, and with an inter-enterprise view in mind while constructing rapid business operational capability. A business enterprise system will most generally provide services at three levels:

1. The strategic level will provide the highest level of information for strategic decision-making.

2. The tactical level will provide information across business functions to assist the horizontal process management of all participating organizations.

3. The operational level allows sharing of pertinent information that execution personnel need to make things happen in the immediate context of providing services to all participants.

The management system of the present invention provides a very versatile business/supply chain assessment feature. The system can establish available industry benchmarks, and thereby define the meaning of success for each organization. The system can also establish the degree of supply chain maturity of an organization, and establish the scope of supply chain performance required of an organization. The baseline for current performance within the supply chain can be established, and extremes can be identified.

The system is further able to analyze organization and structure, quality and measurement, operations management, information and technology, customer and external relationships, and knowledge and its use. The system determines roles within the organization, supply side participants and demand side participants, as well as identifying decision authorities and decision methods. Gaps in performance and characteristics with the model can be established. The system can further focus on the catalyst for change, the most compelling reasons for change, and the willingness of individuals and organizations to change.

Another feature of the present system is providing valuation positioning. Value positioning provides diverse data, such as value proposition curves for potential process changes, organization value priorities, and investment guidelines. The valuation positioning can determine the key metrics that the enterprise has determined as key to their business, establish the sensitivity of metrics at multiple levels to specific changes in performance within supply chain processes, and establish the priorities for the organization with regard to most desired value propositions. The valuation-positioning feature can further determine the likely payback for given initiatives within the organization as an initial means to adjust the focus of effort based on perceived likely value. Value positioning can determine what the potential payback is so that the investment can be gauged for appropriateness, and can obtain client buy-in on value propositions and possible methods for performing projects based on the potential value proposition.

As stated previously, the supply chain management system uses data warehouse design concepts to vertically integrate order management (OM), inventory management (IM), vendor managed inventory (VMI), and transportation management (TM) systems. The system provides a big picture of the operation of a business.

The data warehouse will provide an enterprise-wide performance view of the business operation of the supply chain management system. By consolidating the history of transactions across disparate supply chain management transactional systems, the data warehouse can be queried for a number of business key performance indicators and metrics. These include:

Asset measurement	Revenue
Cost	Customer profitability
Consumer service	Speed
Productivity	Integrated metrics
Quality	Miscellaneous
Timeliness of shipments	

In ordinary operation, it is expected that the customer's supplier information will provide inventory data by product and warehouse, while the customer information furnishes purchase order and inventory data. Purchase order data will be organized by order date, product, supplier, and delivery terms. The customer's customers (customer2) information will provide purchase order, inventory and sales data. The sales data will be transmitted to the vendor managed inventory system. The partner providers, which includes carriers and warehouse facility providers, will transmit shipment data for orders shipped from supplier to the SCM customer, and for orders shipped from SCM customer to customer2. The data will be consolidated in the enterprise Web-Enabled Data Warehouse/Mart. The warehouse can then be queried to develop a host of measures for supplier shipment, supplier inventory, customer purchase orders, customer inventory, customer shipment, customer2 purchase orders, customer2 inventory, and customer2 sales.

Referring to figure 3, a chart illustrating the flow of information according to the supply chain management system of the present invention is shown. In the ETT 58, when an ERP transaction 76 occurs it is logged as an incoming transaction 78 and placed in the receiving queue 80, which in turn launches an electronic messaging process 82. The electronic messaging process 82 interacts with an electronic message database 84, which may send messages to

customer relations management 86, message definitions 88, and/or message definitions 90. An OS Demon/Watchdog 92 monitors the electronic messaging process 82 and the receiving queue 80.

In ODS acquisition, information from the electronic messaging process 82 is sent to a process queue 94. The process queue 94 launches an operational data store process 96, which is monitored by an ODS scheduler Demon/Watchdog 98. The operational data store process 96 updates an operation data store 100 and an SCM repository 102. The SCM repository 102 contains customer and product relations management, and performance measurement metrics.

Information from the operation data store process 96 is sent in a data warehouse transaction to an archive queue 104, which in turn launches a data warehouse marts process 106. A data warehouse demon/watchdog 108 monitors the data warehouse marts process 106. The data warehouse marts process 106 updates the data warehouse 110 and the data marts 112.

The primary points of contact among the software package suites are the individual input data requirements for each system, the data transactions among systems, and vertical integration logic.

The next aspect of the supply chain management system is the order management process functions. For inbound items, inbound processing controls a purchase order (PO) from requisition through payment authorization, which includes sourcing, purchase release, receiving, and payment authorization.

The first step is the monitoring and maintenance of open requisitions, consolidation of stock-keeping unit (SKU) purchase quantities by vendor, and creation of a planned PO, by sourcing. Next, the purchase release creates the P.O., either from a purchase requisition or by direct entry, and establishes purchase price, considering any special discount schedules or volume purchase agreements. It also creates the authorization to receive product in the Warehouse Management system, and follows the progress of the order from time of requisition through receipt.

In the receiving step, the incoming products are identified, and verification that they were ordered is made. The product is then controlled through counting and quality control. The

receiving step supports put-away tasks, and posts the record of receipt, including date and quantity shipped, based on an authorization to pay from warehouse management.

The final step is payment authorization. Here, invoices from vendors are authorized for payment by determining that the quantities invoiced were received at the purchase price invoiced. Exceptions are noted and the appropriate manager is notified.

In outbound processing, the customer order from time of product creation through billing is controlled, which includes sourcing, order release, shipping, and invoicing.

In the sourcing step, any customer, product, and any special pricing requirements are identified. Credit checks are performed, and inventory availability is determined. Inventory required for immediate shipments are then reserved.

In the order release step the requirements for future delivery of non-standard product, back-ordered items, or scheduled shipments are captured. Next the authorization to ship for items that can be shipped immediately are created.

In the shipping step outbound products are identified, quantities picked are confirmed, products are controlled through packing, quality control, and shipping, and the record of shipment, including date and quantity shipped, based on an authorization to bill from warehouse management is posted.

The next step is the invoicing step. Here, all orders shipped to a customer are invoiced. Exceptions are noted and the appropriate manager is notified.

The final step is physical distribution. Physical Distribution controls the warehousing and transportation of all orders as follows:

Distribution Center Planning

1. Plans and manages efficient and economical strategic center's (SC) operations based on order backlog, supply, storage capacity, and available manpower.

2. Schedules inbound receipts based on authorizations to receive (ATR).

3. Directs put-away operations either cross-dock to fill order backlog, such as back-orders or scheduled releases, or to storage.

4. Releases outbound orders for shipment based on authorizations to ship (ATS).

5. Directs inventory replenishment to support established picking procedures, and

6. Controls work queues in support of these operations.

Picking

1. Identifies outbound products; confirms quantities picked.

2. Controls product through packing, quality control, and staging, and

3. Updates inventory balances.

Put-Away

1. Identifies inbound receipts.

2. Controls product through counting and quality control.

3. Supports put-away tasks; and updates inventory balances.

Storage Management

1. Establishes and maintains the warehouse location map.

2. Maintains perpetual inventory balances.

3. Controls internal movement of product, including put-away and replenishment requirements.

Billing is the link between Inventory Management and Financial Management in the receivable area. All orders shipped to a customer are invoiced. Exceptions are noted and the appropriate manager is notified. The order management process functions are identified in Figure 4.

In order management (OM), new customer information is created in step 120. Items, customers and suppliers are maintained in steps 122, 124, and 126, respectively. In step 128, a confirmation of a valid order is produced in response to the customer. The order is sent to distribution center planning 132 through Assian lines 130. A put away is created in step 134.

The data from steps 122, 124, and 126 are also employed in data validation step 140, which is part of the transportation management system (TMS) as well as the business. When the data is validated in step 140, confirmation is sent back to process the valid order received step

128. In addition, as part of the vendor managed inventory (VMI), a deployment plan 142 is created after the data validation.

Information from the step of creating the put away 134 is sent to a shipment received step 144, which in turn is sent to a shipment received step 146 at the customer end. Both shipment received steps 144 and 146 send confirmations to transaction receipt step 148, which produces an invoice payable 150.

The data validation steps 140 are part of a larger data capture step 150. Customer history 152 is used in a forecasting step 154 so that the data validation step 140 can utilize this information in the creation of the deployment plan in step 142. The data capture step 150 also produces a new customer contract in response to a valid order from a new customer in step 156.

As part of the order validation process, supplier sourcing is determined in step 160. The selected supplier information is sent to supplier order entry step 162 and to tendering step 164. The supplier order entry step 162 initiates an order received step 166, and is further used in the data validation step 140. Finally, the transaction receipt step 148 initiates a customer invoice payable 170.

The functions of the inventory management process are forecasting, deployment, leveling, and replenishment. Inventory Forecasting determines what to stock. Provides statistical and/or empirical techniques to forecast product demand, based on historical sales performance.

Inventory deployment manages planned availability for each SKU, including:

1. How much to stock, based on projected demand.

2. Where to stock to satisfy established service levels.

3. When to replenish to maintain established levels.

4. How much to buy, based on the following economic order quantities:

a.) Availability Management

Manages planned availability for each SKU, including quantities on hand, on order, committed, and quarantined.

b) Inventory Leveling

Allocates planned availability to fill customer orders or to maintain stocking levels in the distribution network.

Determines net requirements based on planned allocations.

Identifies excess inventory.

Recommends adjustments to minimum stocking levels.

Recommends whether inventory will be bought or transferred to maintain recommended stocking levels.

c) Inventory Replenishment

Generates requisitions to either buy or transfer inventory to meet net requirements in the distribution network.

The functions of vendor managed inventory are demand planning, inventory planning, inventory deployment, sourcing, order release, and shipping.

Demand planning determines what to stock. Provides statistical and/or empirical techniques to forecast product demand, based on historical sales performance.

Inventory planning manages planned availability for each SKU, including:

1. How much to stock based on projected demand.

2. Where to stock in order to satisfy established service levels.

3. When to replenish to maintain established levels.

4. How much to buy based on economic order quantities.

Inventory deployment performs a number of functions, namely, it allocates planned availability to fill customer orders or to maintain stocking levels in the distribution network. Inventory deployment determines net requirements based on planned allocations, identifies excess inventory; recommends adjustments to minimum stocking levels, recommends whether inventory will be bought or transferred to maintain recommended stocking levels, and generates requisitions to either buy or transfer inventory to meet net requirements in the distribution network.

Sourcing (common with order management) assists in identifying customer, product, and any special pricing requirements, performs credit checks determines inventory availability, and reserves inventory required for immediate shipments.

Order Release (common with order management) captures requirements for future delivery of non-standard product, back-ordered items, or scheduled shipments, and creates the authorization to ship for items that can be shipped immediately.

Shipping (common with order management) identifies outbound products, confirms quantities picked, controls products through packing, quality control, and shipping, and posts the record of shipment, including date and quantity shipped, based on an authorization to bill from warehouse management.

The functions of warehouse management are distribution center planning, picking, put-away, storage management, and inventory accounting.

Distribution center planning plans and manages efficient and economical SLC operations based on order backlog, supply, storage capacity, and available manpower, schedules inbound receipts based on Authorizations To Receive (ATR) from Purchase Management, directs put-away operations either cross-dock to fill order backlog, such as back-orders or scheduled releases, or to storage, releases outbound orders for shipment based on authorizations to ship from Order Management, directs inventory replenishment to support established picking procedures, and controls work queues in support of these operations.

The picking function identifies outbound products, confirms quantities picked, controls product through packing, quality control, and staging, and updates inventory balances. Shipping functions related to order processing controls, bills of lading, truck manifests, and billing procedures are included in the Order Management checklists.

The put-away function identifies inbound receipts, controls product through counting and quality control, supports put-away tasks, and updates inventory balances. Receiving functions related to purchase order controls and payment procedures are included in the Purchase Management checklists.

The storage management establishes and maintains the warehouse location map, maintains perpetual inventory balances, and controls internal movement of product, including put-away, multiple customers per location/bin and replenishment requirements.

The inventory accounting controls real-time inventory updates, provides on-line inquiry to perpetual balances; and supports cyclical/physical inventory procedures, (an effective Warehouse Management functionally isolates warehouse business operations from other business operations.) Work requirements are received as either authorizations to ship (ATS) from order management or authorizations to receive (ATR) from purchase management.

The warehouse management controls planning, inbound, outbound, and storage management operations. The warehouse automation controls the actions of any automated devices, such as carousels, fixed scanners, and palletizers. When a required business operation, such as shipment or receipt, is completed, authorizations to bill (ATB) or authorizations to pay (ATP) are returned as appropriate. Periodically, reports are generated of on-hand inventory to the inventory management and financial management. The Warehouse Management process flow is shown in Figure 5.

An availability manager 200 monitors the movement of goods, and receives goods receipts 202, and produces goods issues 204. Authorizations to ship goods (ATS) are sent by the availability manager 200 to a pick planner 206, and includes prioritized customer information, ship date/time information, and transit time information. The information from the pick planner is sent to a shipment planner step 208 that produces load planning and tendering information. A pick order step 210 is performed based on the information from the shipment planning step 208. The pick order step 210 produces directed picking information, updated location status information, first-in-first-out information, labeling and scanning information, customized pallet information, and building, case pick, and order assembly information.

The information from the pick order step 210 is used to perform a ship orders step 212, which is sent to both the availability manager 200 and an ATMS step 214. In the ATMS step the carrier system is selected, the load is tendered to the carrier, and a carrier assignment is made.

Periodically a count of the physical inventory is cycled in step 216. Storage management step 220 is performed parallel to the availability manager 200. The storage management step monitors the available storage space, storage locations including storage configurations,

replenishment, and re-warehousing. Furthermore, the storage management 220 performs productivity analysis and management reporting, produces performance measures, and monitors equipment utilization and maintenance.

Product monitoring is the ability to inquire and report the current location, quantity, and status of products throughout the supply chain at any time. Two categories of information are supported: inventory visibility and in-transit visibility. Through automated and manual procedures, Product Monitoring provides a consolidated view of all products across warehouses, vendors, customers, and in-transit modes.

As a result, customers can track and manage in-transit progress. By proactively tracking in-transit progress the customer can identify potentially late deliveries in time to redirect the shipment and plan loads for possible deliveries enroute. Customers can consider alternate sourcing. By viewing total inventory status, customers can determine the most appropriate location from which to fill an order. Furthermore, customers can combine individual visibility solutions to Enterprise visibility. By consolidating information across multiple departments and organizations, the customer can see a total view of their supply chain, including internal organizations and external partners. Finally, customers can automate tracking to lower costs. Product Monitoring Automation will reduce the staff required to track the product and resolve both internal and external inquiries. The product monitoring process flow is shown in Figure 6.

A query 250 initiates a determination 252 whether in-stock status is required. If the answer is yes the inventory is viewed in step 254. The view inventory step 254 sends and receives information with the order management status in step 256. Next, a decision 258 is made whether in-transit status is required. If no in-transit status is required a query response step 260 is performed.

If in-stock status is not required in step 252, or if in-transit status is required in step 258, then view transit step 262 is performed. In the course of step 262 shipment information 264 is shared. A carrier and an expected delivery date are determined in step 266. A carrier bill of lading file is maintained in step 268. The delivery is validated in step 270 and the data is confirmed in step 272. If the data is correct the query response is generated in step 260, and if incorrect the carrier bill of lading file is updated in step 274.

A bill of lading (BOL) is created from shipment information. The transportation management auto-rating program, diagramed in Figure 7, validates the shipment information, creates bill of lading records, and calculates the freight cost for the bills of lading. If the freight cost is successfully calculated, shipment history and charge history records are created. The network 300 receives information from the shipper 302, the carrier 304, the consignee 306, and the freight/ vehicle 308.

In the case of consolidated shipment, the shipment is contained within a master bill of lading. Each individual shipment of the consolidation retains a separate bill of lading. Transportation management refers to the master bill of lading as a bill of lading group.

When the shipment is populated with shipments transported under a master bill, a shipment interface record with the bill of lading group ID must be populated as well as all individual bills of lading referencing the master bill of lading number. If a shipment interface record is entered without a detail record (individual bill of lading), the auto-rating program will create a master bill of lading instead of a single bill of lading.

A BOL is created either from shipment information received through the shipment interface or when shipment information moves from shipment planning to shipment execution. Transportation management rates the line haul portion and the distribution leg separately for shipments going through a pool point. The shipment interface will need two types of records, the line haul shipment with the master bill of lading information and each distribution leg for individual sub-bill of lading information. The through point on the shipment interface record has to be populated with the pool point location.

Track a shipment by the contents (i.e., cookies, candies, chocolate, etc.) in a package. Transportation management generates non-cartonized bills of lading when a shipment tracked by package content is rated. Non-cartonized bills of lading list itemized products (ship items), and provide specific instructions to a carrier on a BOL (i.e., Inside Delivery, Hot Delivery or Delivery to Room 210).

The status notification receives a delivery status notification through the EDI 214 Delivery Status Transaction set. A carrier can transmit the shipment tracking status via EDI to an organization (either the shipper or customer), eventually to be populated in transportation management.

Shipment tracking is accomplished through the use of delivery status messages. These messages are added to the shipment history record.

Referring to Figure 8, a graphical representation of the data warehouse/marts infrastructure according to the present invention is shown. The ETT 58 draws information from the existing ERP and operating system 56, external feed data 350, and text, image and video data 352. Information from the ETT 58 is sent to the information directory 52, which in turn send s information to the operational data store 60, the data warehouse time series 54 and the information creation 70. The information creation 70 sends information to the data marts 62, exceptions and alerts 354, and DSS tools 356. Furthermore, knowledge base distribution 360 is fed to the data marts 62, exceptions and alerts 354, and DSS tools 356.

A graphical representation of an N-Tier network/server architecture according to the present invention is shown in Fig. 9. In a presentation tier, the system is viewed through a web browser 400. A web server Intra/Internet 402 forms a distribution tier 404. A publication tier is made up of at least one web application server. A ROLAP/ application tier includes a web agent/broker 406 and stored process cartridges 408. The data marts tier includes enterprise servers 410 and 412. The data Warehouse tier is connected tot he enterprise servers 410 and 412 and includes an ORDBMS server 416. Finally a source tier includes source data legacy systems 416 and source data (COTS) 418.

Referring to Fig 10, a graphical representation of a base view of the supply chain according to the present invention is shown. A customer 440 receives inventory from a supplier 442 and ships to customer2 444. A partner provider 446 carries the goods from the supplier 442 to the customer2 444.

Fig. 11 is a graphical representation of meta views of the supply chain management according to the present invention. A customer to customer shipment 450 is graphed to show the shipment mode over time. Aggregate customer shipment is represented by a graph 452 of customer verses partner provider over time. Customer inventory is represented by a graph 454 of warehouse inventory verses product over time.

Referring to Fig. 12, a graphical representation of a meta view of the supply chain measurement according to the present invention is shown. The factual data 460 is disseminated

into product dimension data 462, channel dimension data 464, time dimension data 466, and customer dimension data 468.

A flow chart of integrated logistics for the supply chain management system according to the present invention is illustrated in Fig. 13. A sales plan 600 is developed and process, volumes, and planned promotions are sent to promotional management 602, and category management and customer contact team 604, and a sales forecast is sent to distribution planning 606. The distribution planning sends adjustments to supply planning 608 and demand planning 610, which in turn send supply and demand information back to the distribution planning 606. The distribution planning 606 net requirements to deployment planning 610 that returns availability information back to the distribution planning 606.

Supply planning 608 sends promotion requests and planned orders to vendors and suppliers 612, planned orders to inbound order management 614, and a supply plan to the deployment planning 610. Order management returns an on order inventory to the supply planning 608. Inbound order management 614 further sends on order inventory to the deployment planning 610, purchase information to the vendors and suppliers 612, matched receipts to accounts payable 616, and authorization to receive orders and to ship returns to warehouse management 618. The vendors and suppliers 612 send return authorization and invoices to the inbound order management 614. Deployment planning 610 sends planned transfer information to inbound order management 614. Warehouse management 618 sends authorization to pay to inbound order management 614.

Accounts payable 616 receives invoices from the vendors and suppliers 612 and sends payments and deductions to the vendors and suppliers 612.

Demand planning 610 sends planned orders to outbound order management 620, which in turn sends ship point demand data to demand planning 610. Outbound order management 620 sends committed inventory information to the deployment planning 610 and receives planned transfers in return. Outbound order management further sends return authorization and invoices to category management and customer contact team 604, which returns orders. The invoices are also sent to accounts receivable 622. The category management and customer contact team 604 further sends promotional requests and planned orders to demand planning 610, payments and deductions to accounts receivable 622, and returns to warehouse management 618.

Credit status is sent by accounts receivable to warehouse management 618, which also receives authorization to ship orders and to receive returns from the outbound order management 620. Warehouse management sends authorization to bill to outbound order management 620, and cyclical inventories to the general ledger 624. Warehouse management 618 further receives shipments data from the vendors and suppliers 612, and sends returns in return. Similarly, category management and customer contact team 604 sends shipments to the warehouse management 618 and receives returns therefrom. Warehouse management 618 sends receipts, on hand inventory, and shipment data to deployment planning 610 and receives anticipated workload data in return.

The following is a description of the user interface screens utilized in the present invention. Fig. 14 is a user interface login screen 650, which requires user ID and password. Figure 15 is a system main menu screen 652 that appears upon successful login. Figure 16 shows an SCM operation management system menu 654 that may be accessed through the SCM operation management system menu 654. Figs. 17 and 18 illustrate an accounts payable screen 656 and an accounts receivable screen 658, respectively.

The foregoing screens are the interface through which a user accesses the system set forth previously. Additional user interface screens may be provided to utilize the other features of the present invention set forth in detail previously.

Having described several embodiments of the system and method of supply chain management in accordance with the present invention, it is believed that other modifications, variations and changes will be suggested to those skilled in the art in view of the description set forth above. It is therefor to be understood that all such variations, modifications and changes are believed to fall within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A method of managing a supply chain comprising the steps of:

extracting supply chain data from one of existing systems, new systems, and both existing and new systems for entities in said supply chain;

populating an operational data store with enterprise views of said supply chain data;

mapping process models from Supply Chain Operations Reference (SCOR) model processes to said enterprise views of said supply chain data; and

applying data warehouse techniques to provide analysis of indicators and metrics for said entities in said supply chain.

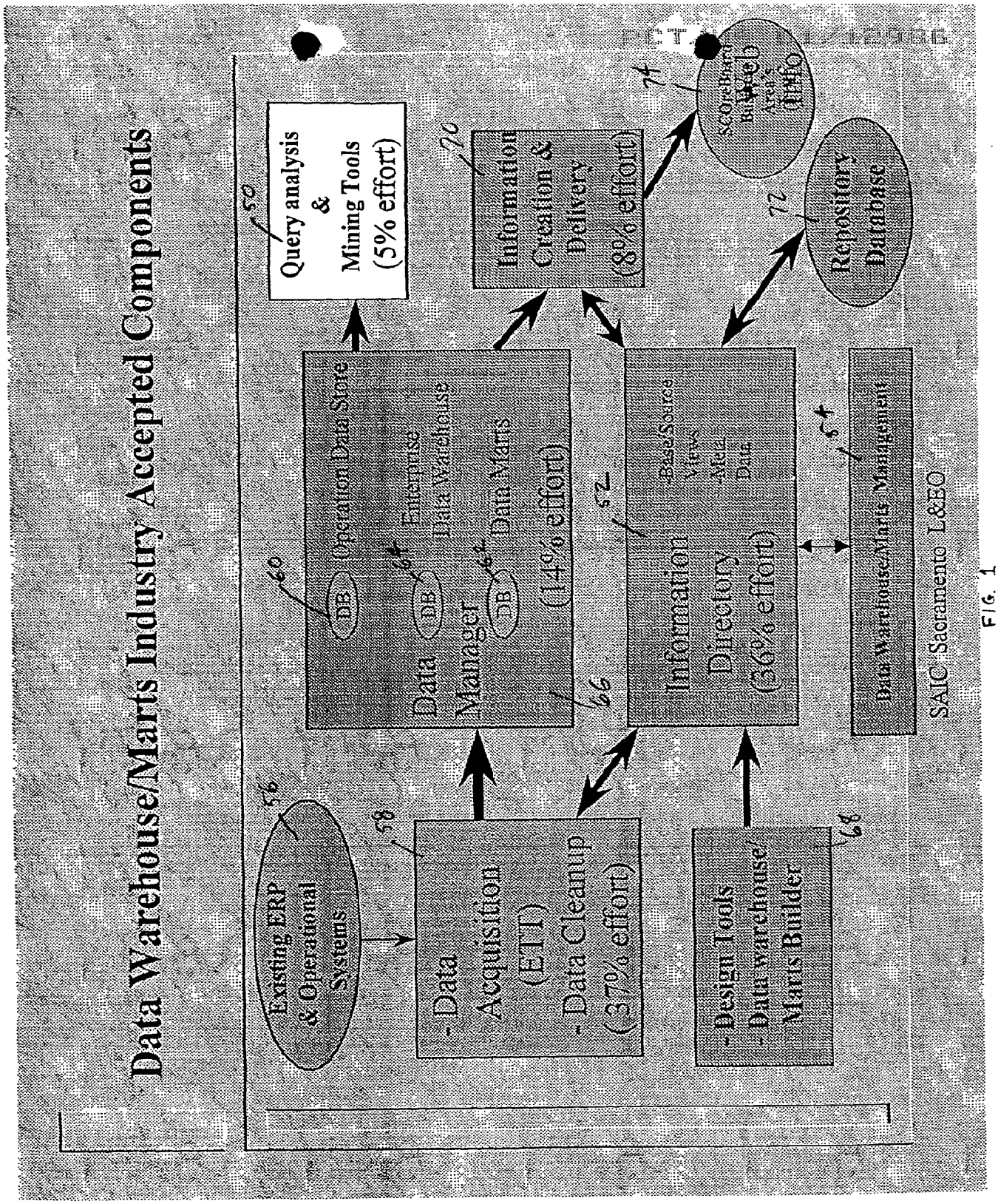

Data Warehouse/Marts Industry Accepted Components
Existing ERP & Operational Systems
5%
58
- Data Acquisition (ETT)
- Data Cleanup
(37% effort)
60
DB
Operation Data Store
DB
Enterprise Data Warehouse
DB
Data Marts
(14% effort)
Data Manager
62
64
Query analysis & Mining Tools (5% effort)
50
Information Creation & Delivery
(8% effort)
70
Information Directory
(36% effort)
Base/Source Data
View Data
Meta Data
52
54
- Design Tools
- Data warehouse/ Marts Builder
66
Data Warehouse/Marts Management
SAIC Sacramento L&EO
Repository Database
72
Scorecard Balanced Analytic Info
74

FIG. 1

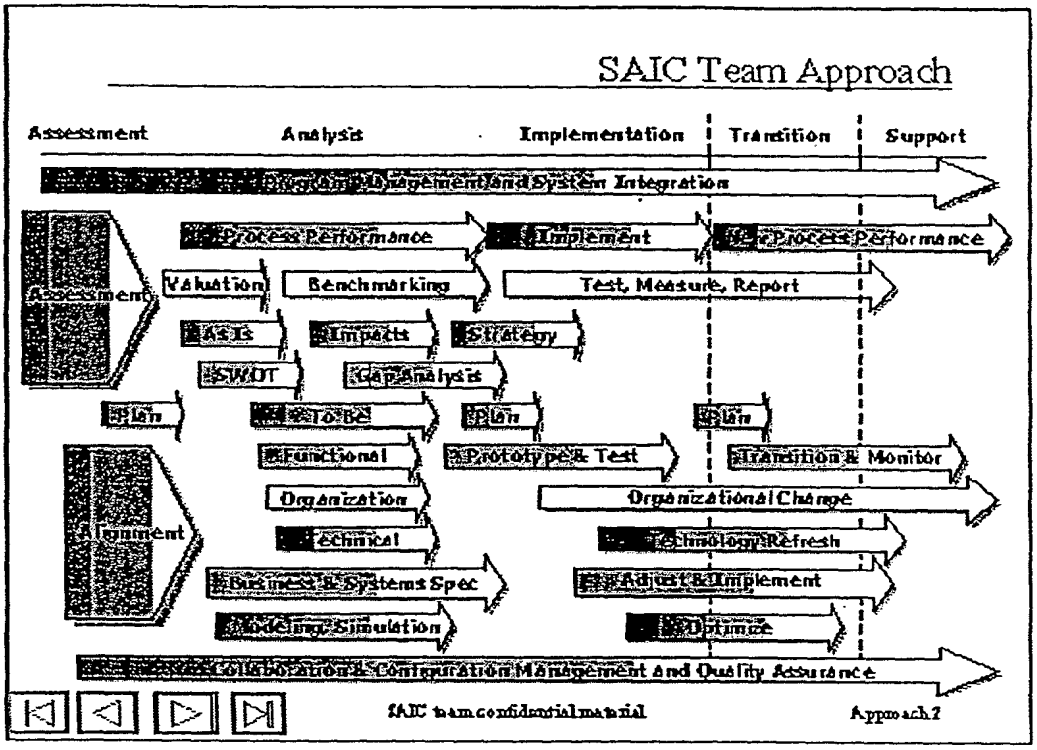


Figure 2. Technical Solution Methodology.

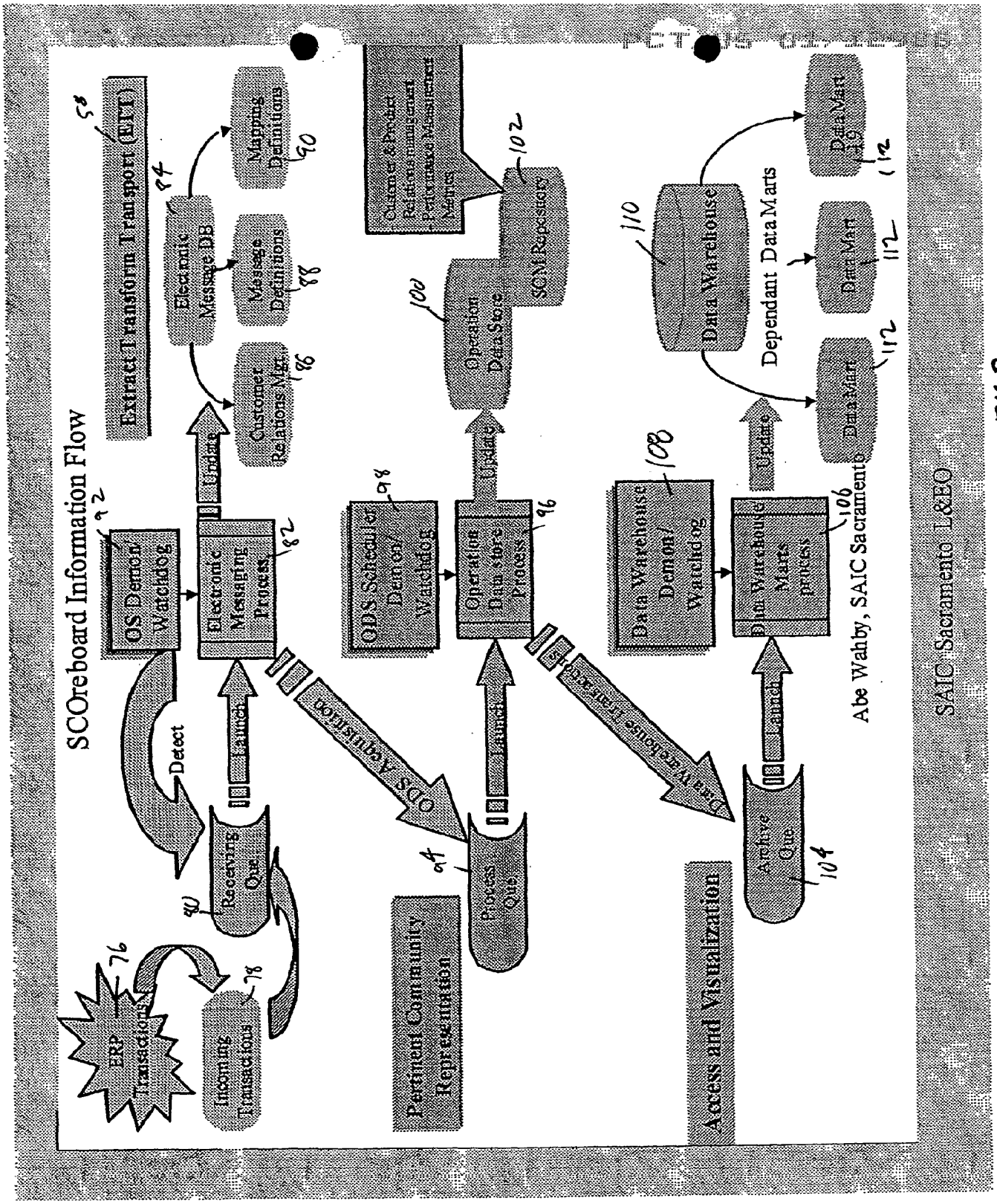

SCOreboard Information Flow
Extract Transform Transport (ETT)
58
Mapping Definitions
90
Electronic Message DB
94
Message Definitions
88
Customer Relations Mgr
86
Update
OS Demon Watchdog
92
Electronic Messaging Process
82
Detect
Launch
Receive Que
84
ERP Transactions
76
Incoming Transactions
78
ODS Scheduler Demon Watchdog
98
Operation Data Store Process
96
Launch
Process Que
94
Persistent Community Representation
Customer & Product Relationship management Performance Measurement Metrics
102
Operation Data Store
100
SCM Repository
Update
Data Warehouse Demon/ Watchdog
108
Data Warehouse Mart process
106
Launch
Archive Que
104
Access and Visualization
Data Warehouse
110
Dependant Data Marts
Data Mart
112
Data Mart
112
Data Mart
112
Abe Wahby, SAIC Sacramento
SAIC Sacramento L&EO

FIG 3

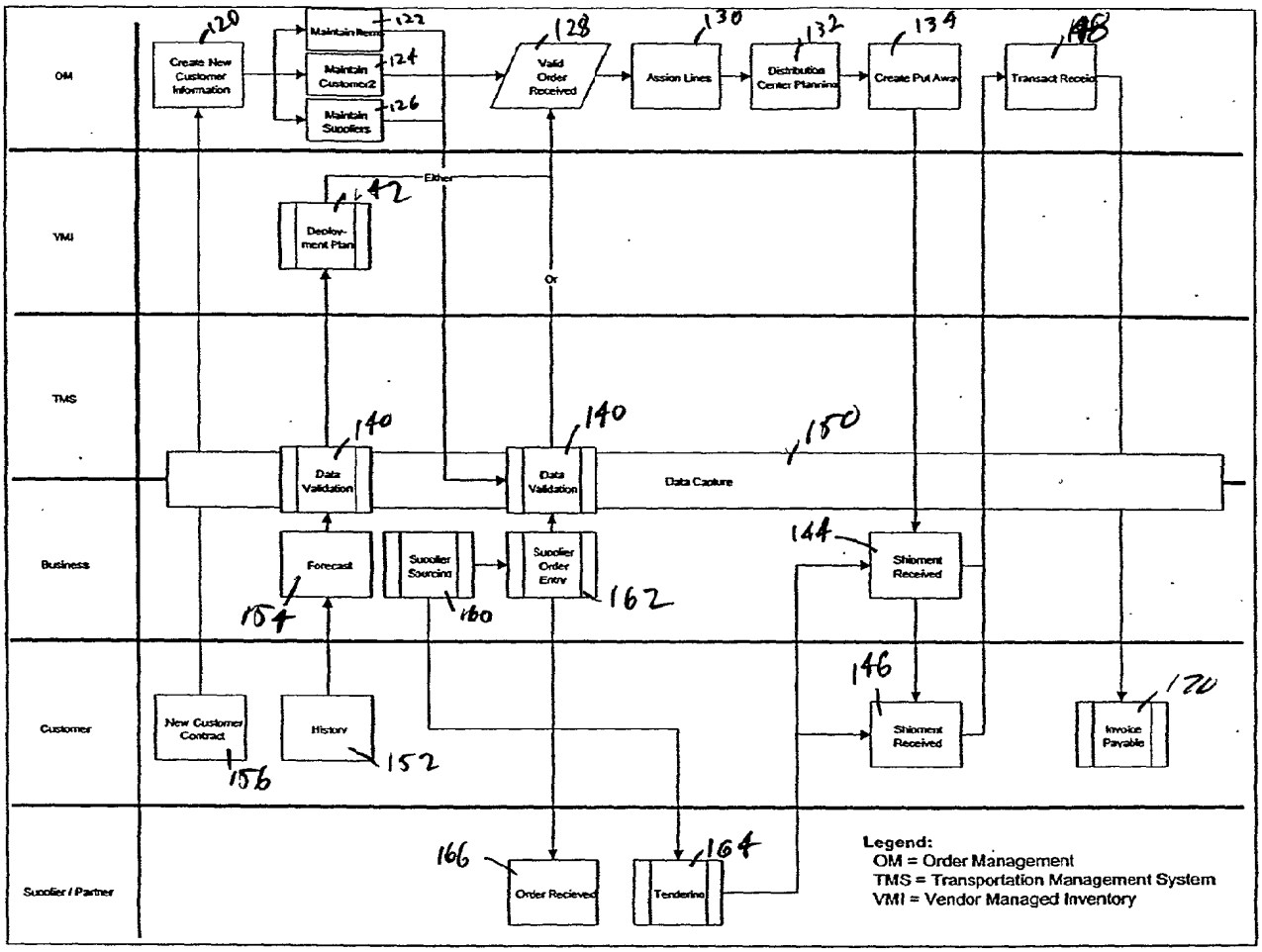


Figure 4. Order Management Process Functions.

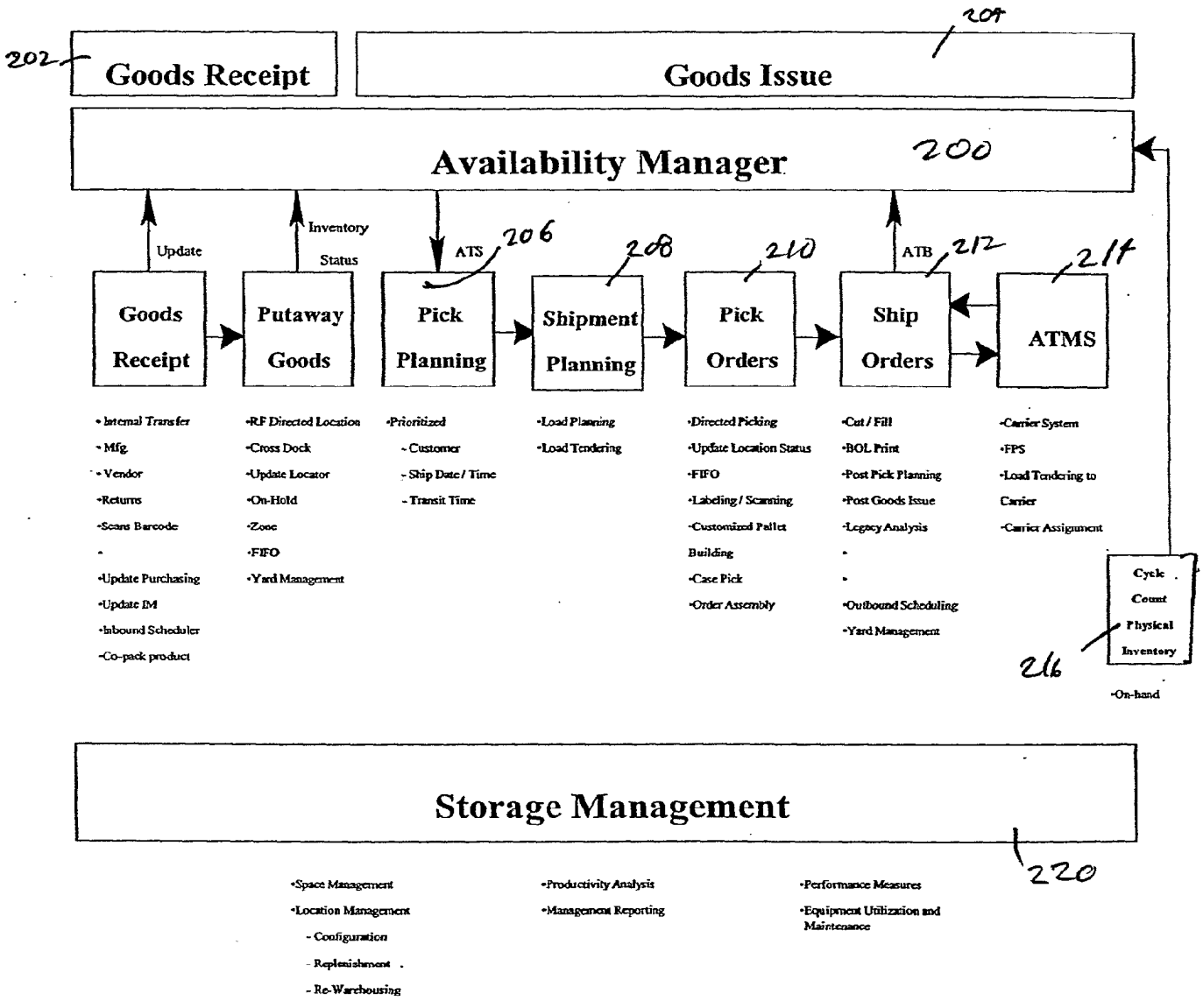


Figure 5. Warehouse Management Process Flow Diagram.

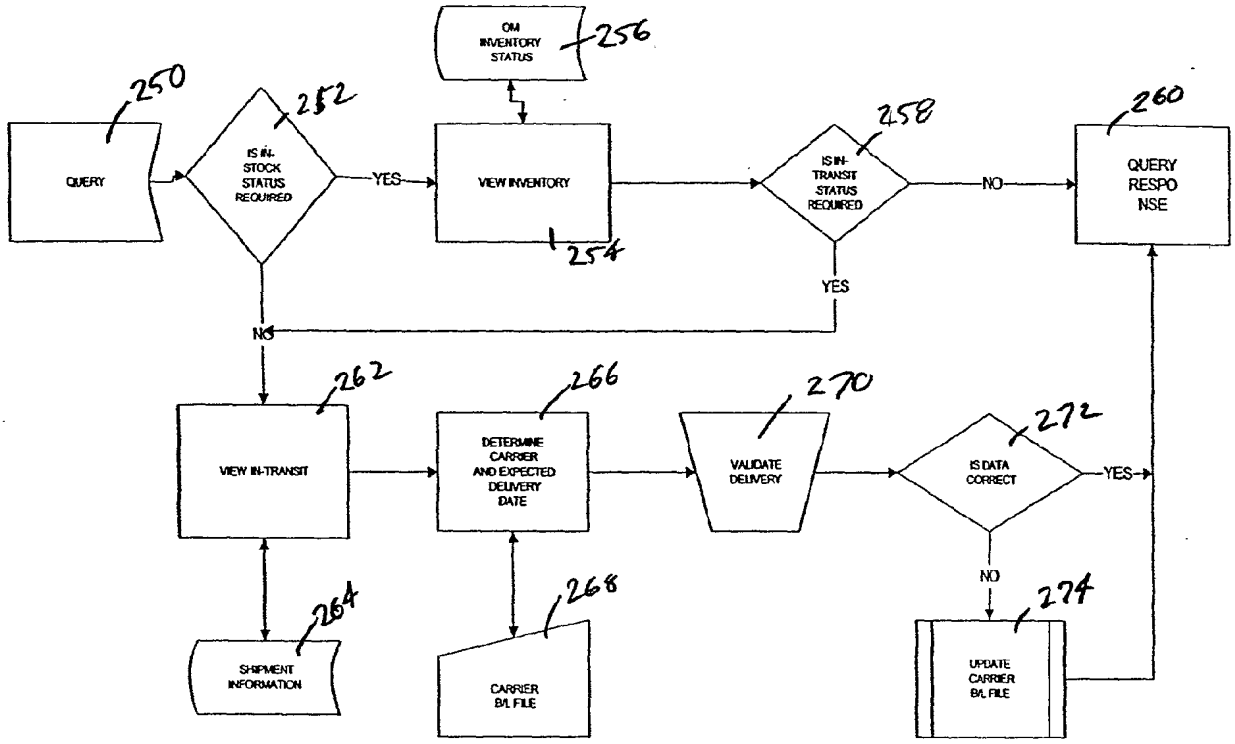
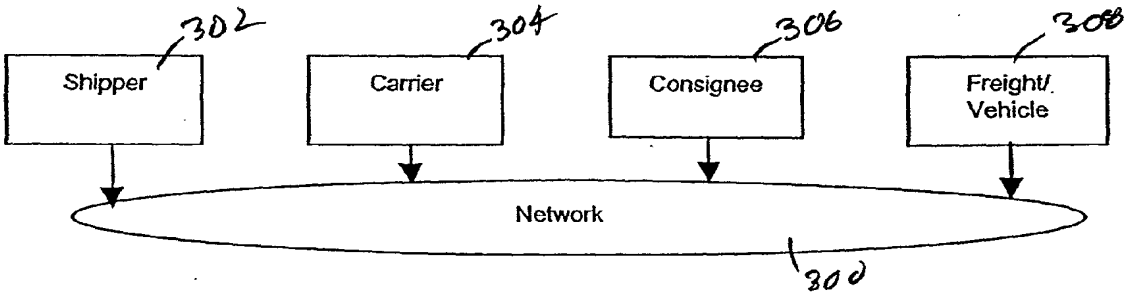


Figure 6. Product Monitoring Process Flow Diagram.



Ship Management	Carrier Operation	Mobile System	Decision Support
* Ship Plan	* Customer service	* Applications	* Carrier select
* Scheduling	* Load plan	* Middleware	* Load select
* Rate/Route	* Fleet management	* Integration	* Load console
* Tracking	* Personnel	* Network	* Clustering

Figure 7.

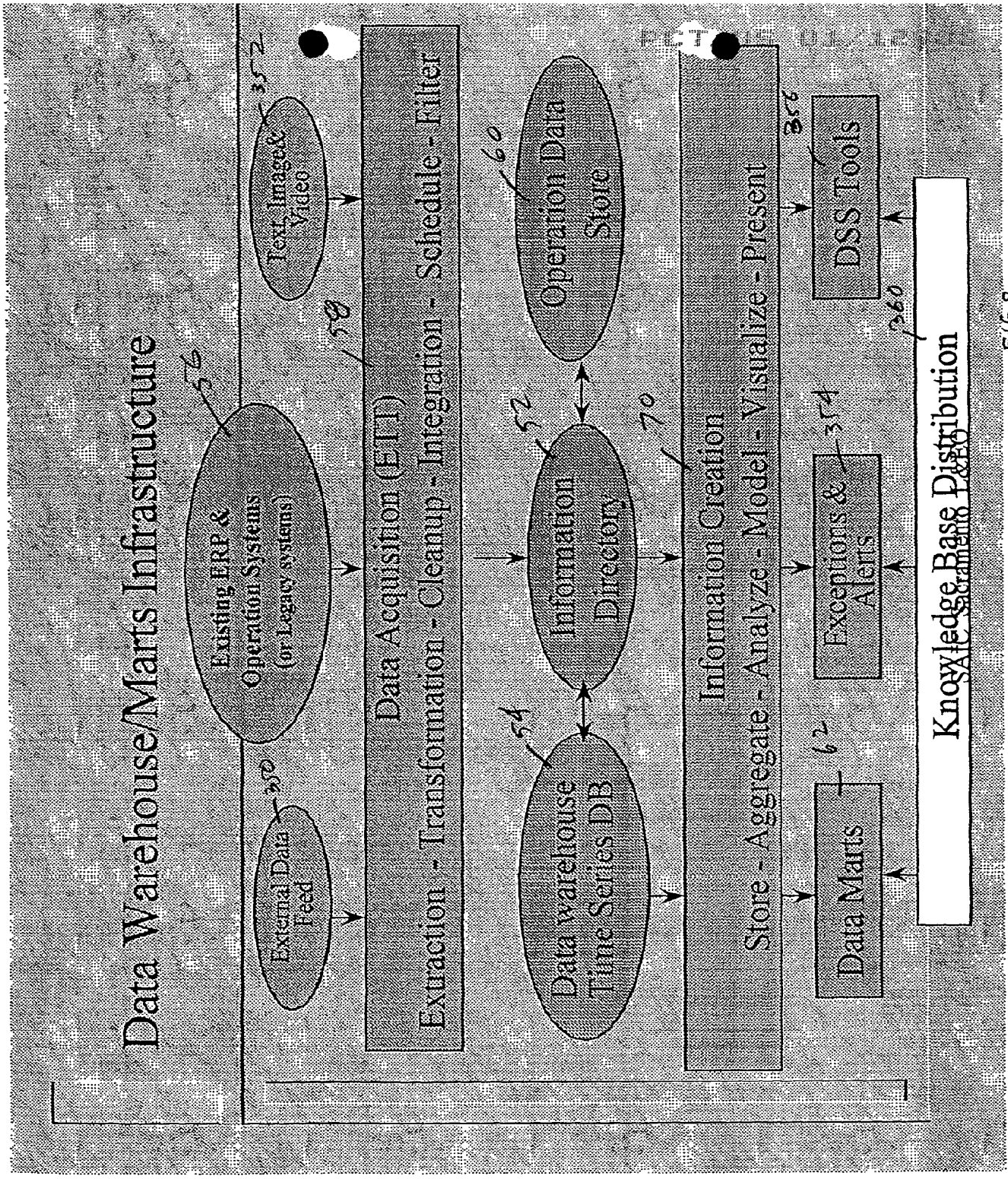

Data Warehouse/Marts Infrastructure
External Data Feed
Existing ERP & Operation Systems (or Legacy systems)
Text, Image& Video
Data Acquisition (ETL)
Extraction - Transformation - Cleanup - Integration - Schedule - Filter
Data warehouse Time Series DB
Information Directory
Operation Data Store
Information Creation
Store - Aggregate - Analyze - Model - Visualize - Present
Data Marts
Exceptions & Alerts
DSS Tools
Knowledge Base Distribution

FIG. 8

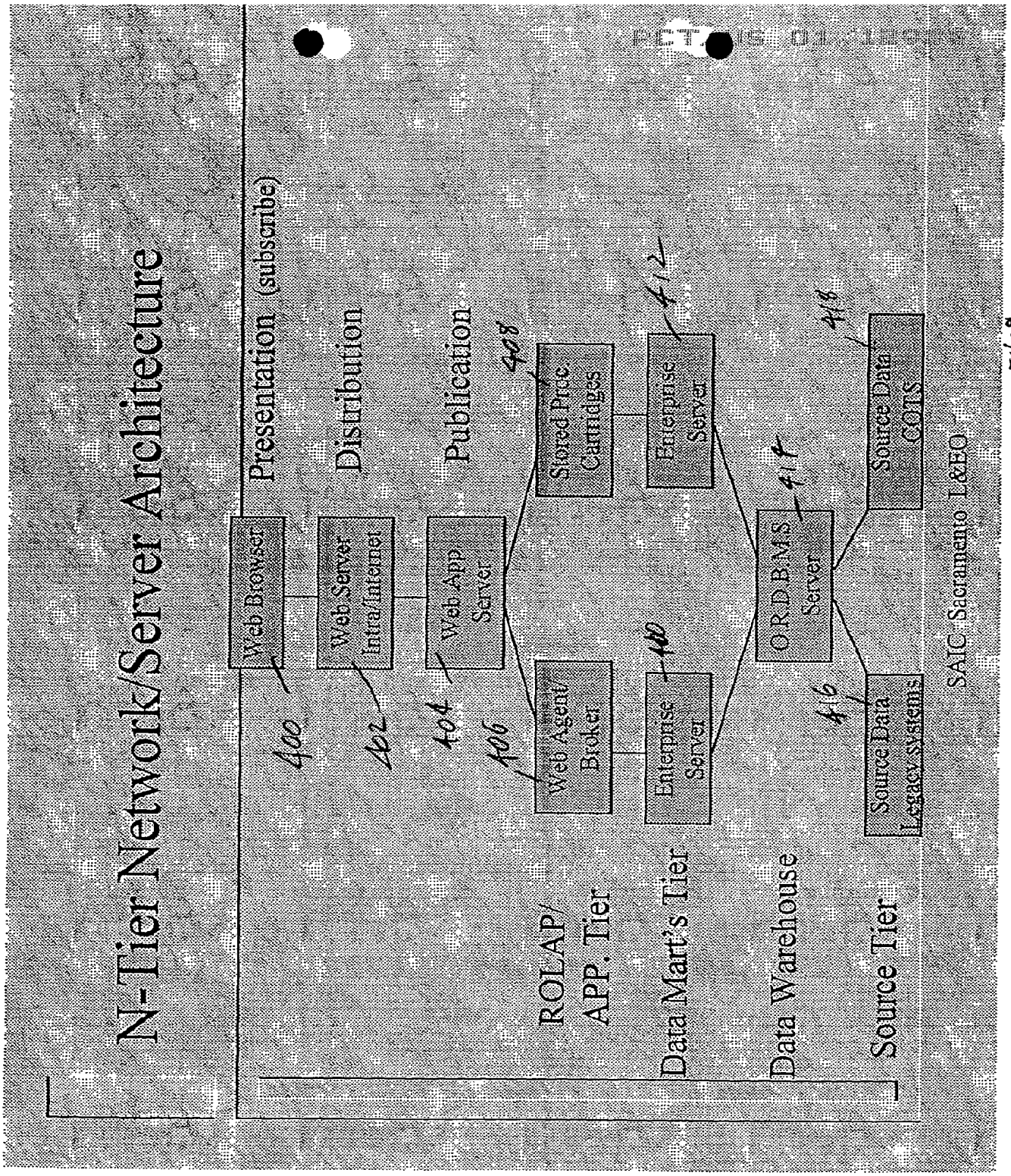

N-Tier Network/Server Architecture
Presentation (subscribe)
Distribution
Publication
ROLAP/
APP. Tier
Data Mart's Tier
Data Warehouse
Source Tier
Web Browser
Web Server
Intra/Internet
Web App
Server
Web Agent/
Broker
Stored Proc.
Cartridges
Enterprise
Server
Enterprise
Server
ORDBMS
Server
Source Data
COTS
Source Data
Legacy Systems
SAIC Sacramento L&EO
400
402
404
406
408
410
412
414
416

FIG. 4

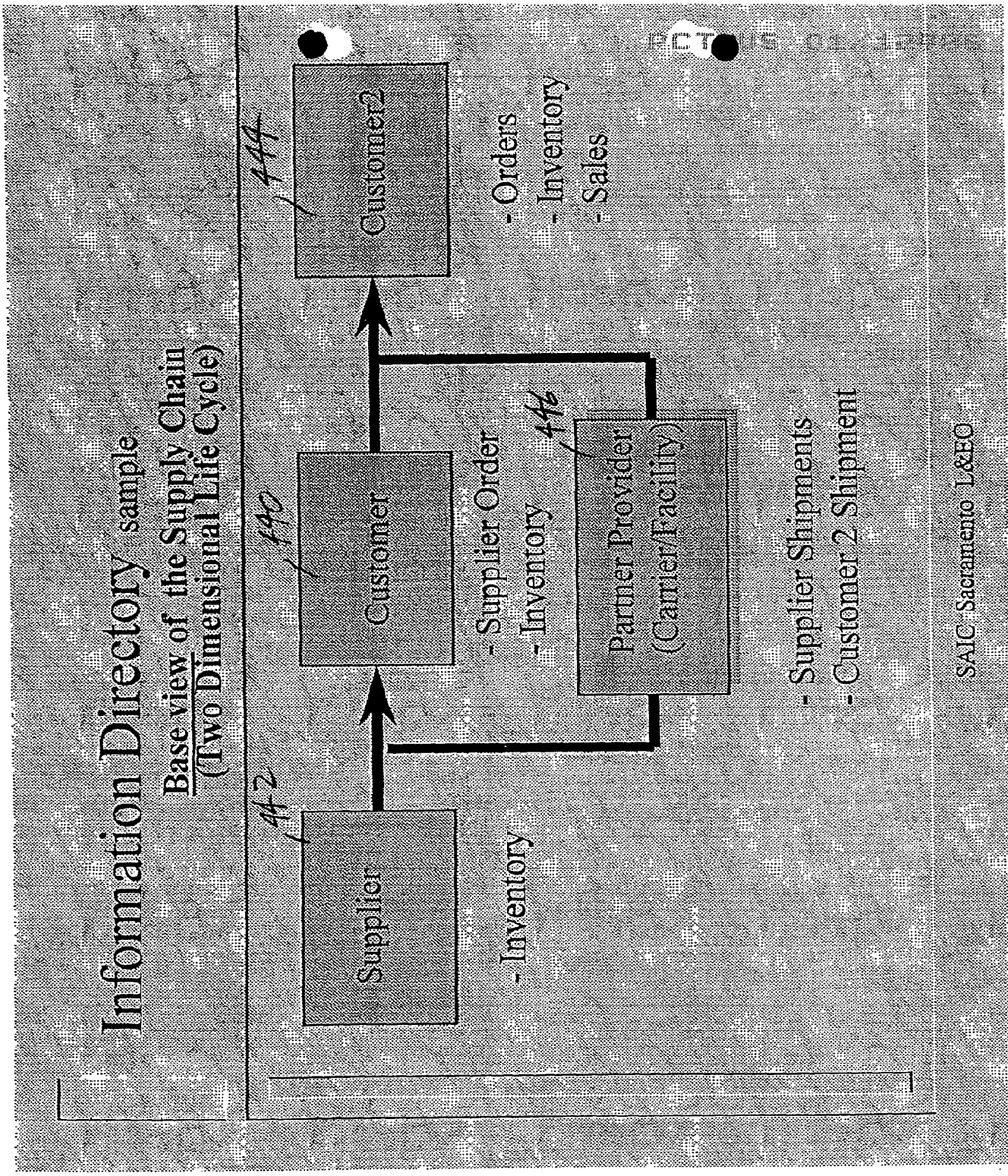

Information Directory sample
Base view of the Supply Chain
(Two Dimensional Life Cycle)
442
Supplier
- Inventory
440
Customer
- Supplier Order
- Inventory
446
Partner Provider
(Carrier/Facility)
- Supplier Shipments
- Customer 2 Shipment
444
Customer2
- Orders
- Inventory
- Sales
SAIC Sacramento L&EO

FIG. 10

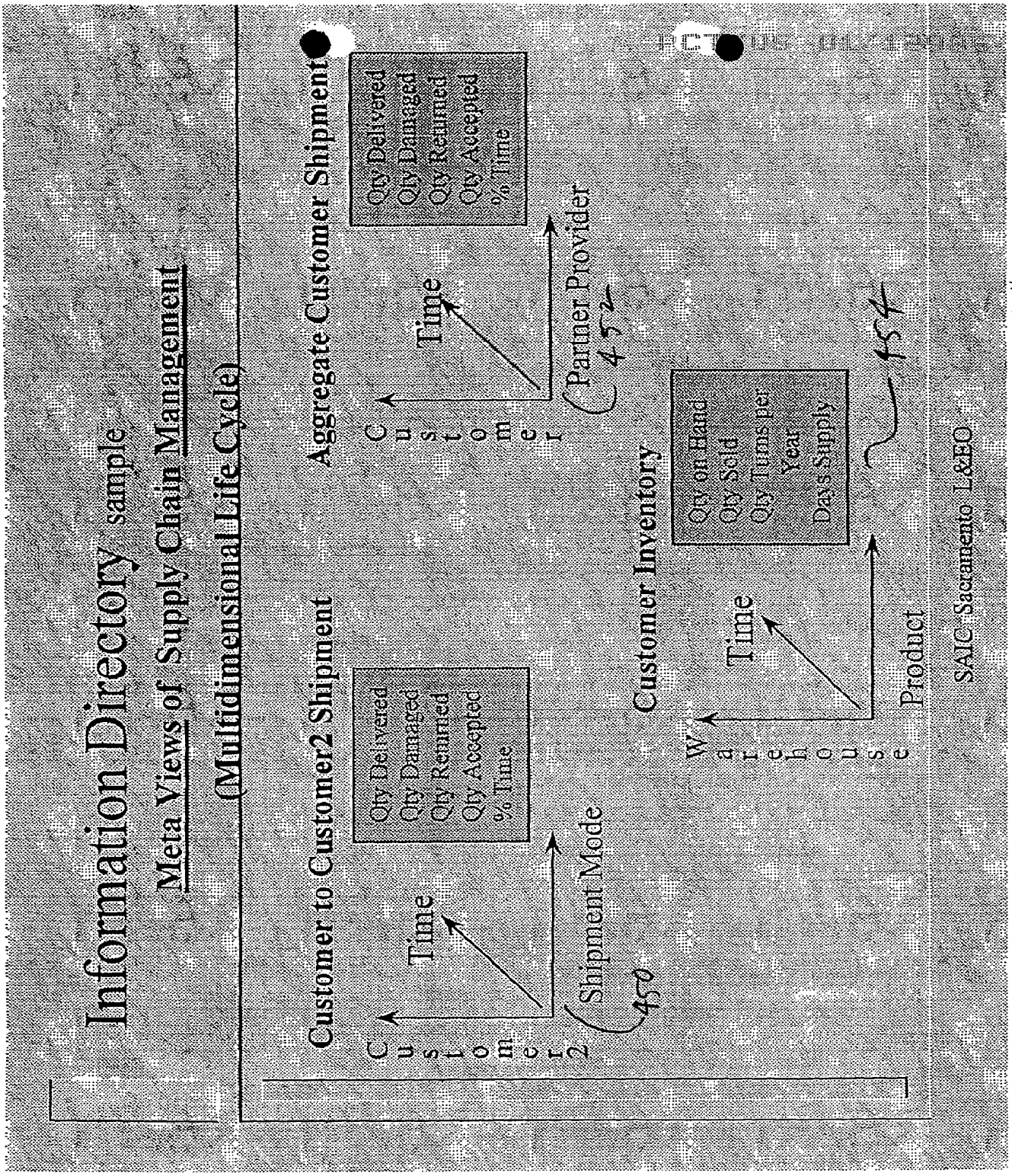

Information Directory sample
Meta Views of Supply Chain Management
(Multidimensional Life Cycle)
Customer to Customer2 Shipment
Customer2
Time
Shipment Mode
450
Qty Delivered
Qty Damaged
Qty Returned
Qty Accepted
% Time
Aggregate Customer Shipment
Customer
Time
Partner Provider
452
Qty Delivered
Qty Damaged
Qty Returned
Qty Accepted
% Time
Customer Inventory
Warehouse
Time
Product
454
Qty on Hand
Qty Sold
Qty Turns per Year
Days Supply
SAIC Sacramento L&EO

Fig. 11

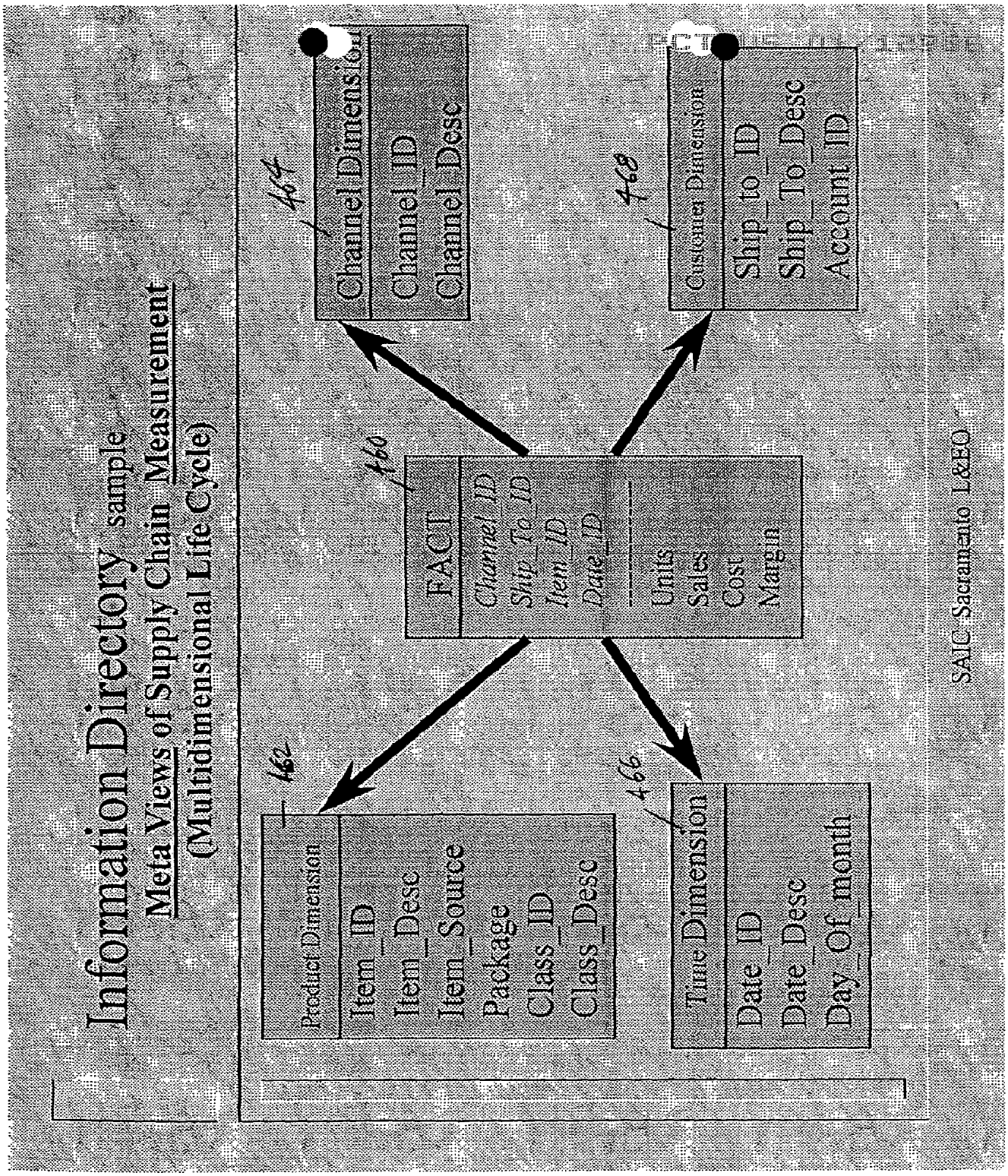

Information Directory sample
Meta Views of Supply Chain Measurement
(Multidimensional Life Cycle)
Product Dimension
Item_ID
Item_Desc
Item_Source
Package
Class_ID
Class_Desc
462
FACT
Channel_ID
Ship_To_ID
Item_ID
Date_ID
Units
Sales
Cost
Margin
460
Channel Dimension
Channel_ID
Channel_Desc
464
Customer Dimension
Ship_to_ID
Ship_To_Desc
Account_ID
466
Time Dimension
Date_ID
Date_Desc
Day_Of_month
SAIC Sacramento L&EO

FIG. 12

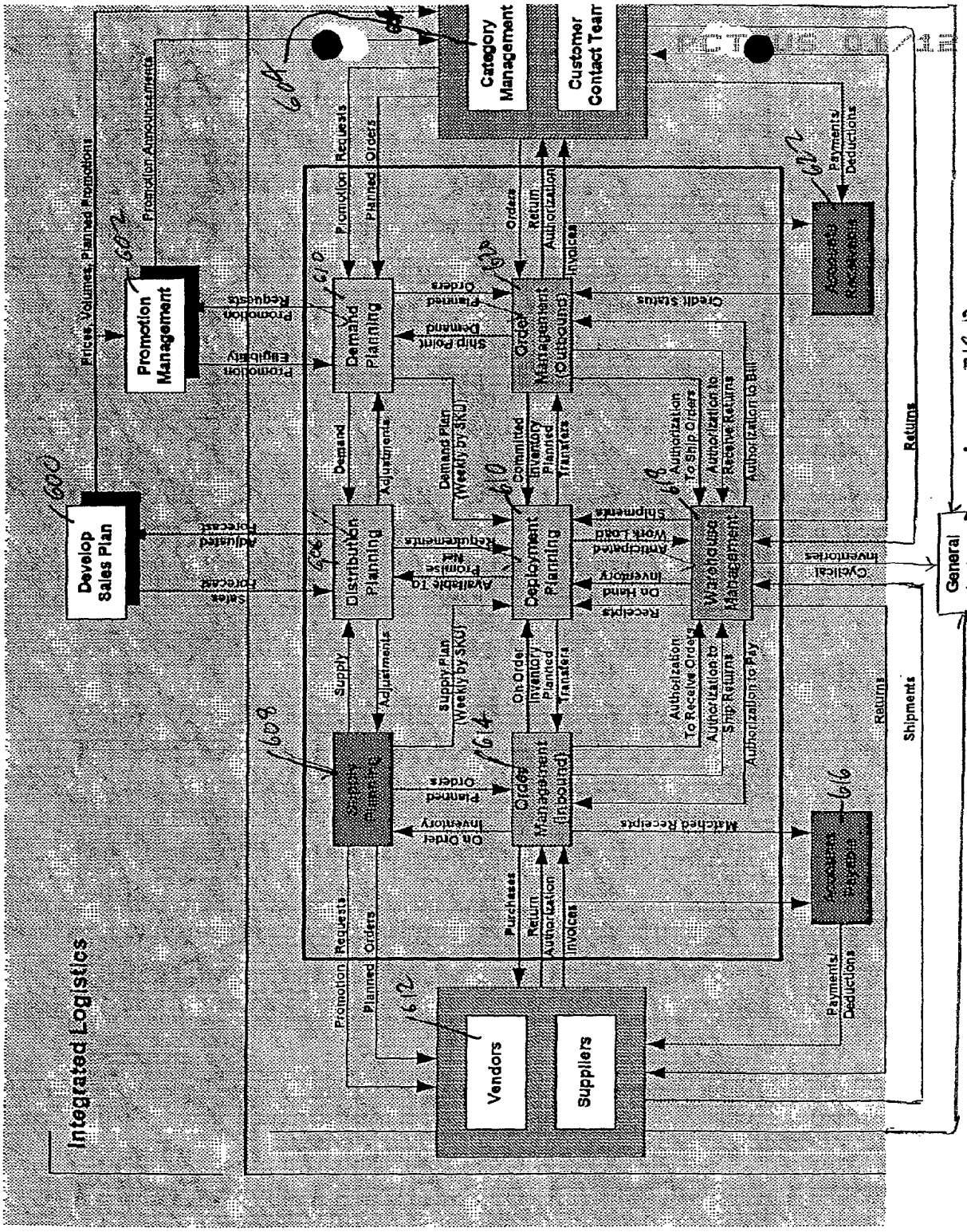


FIG. 13

SAIC Sacramento L&EO

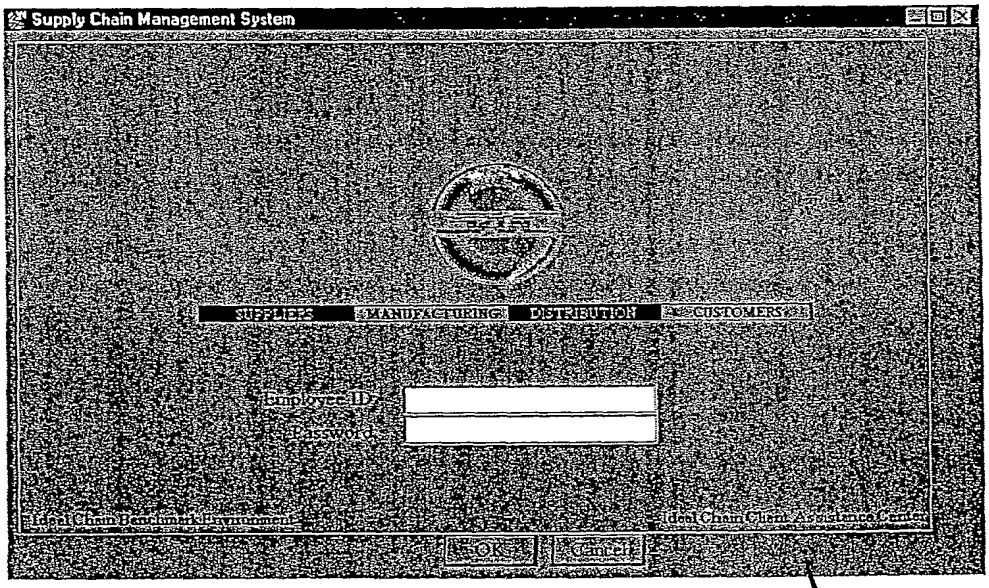

Supply Chain Management System
SUPPLIERS
MANUFACTURING
DISTRIBUTION
CUSTOMERS
Employee ID
Password
OK
Cancel
650

Fig. 14

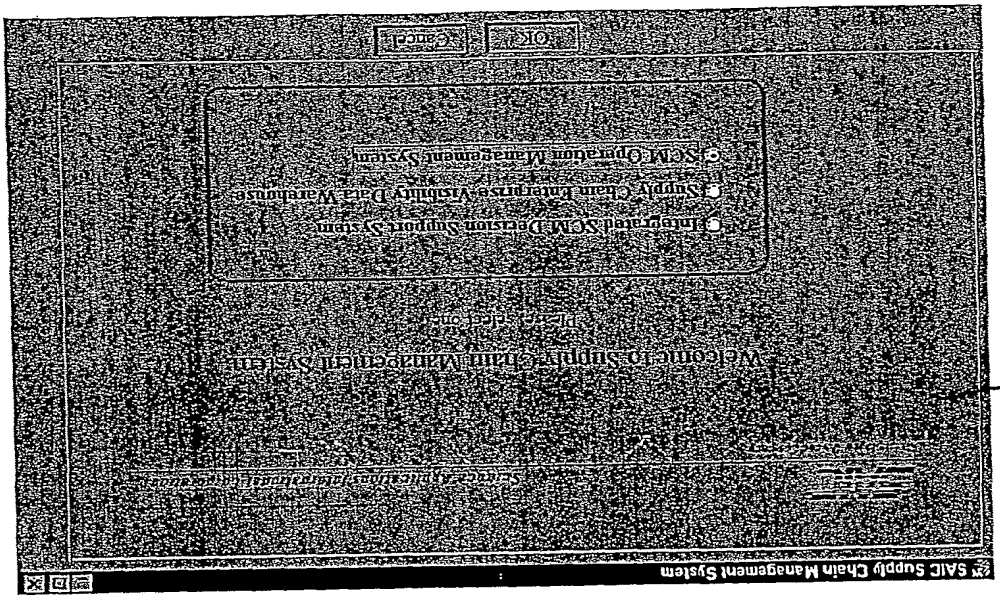

652

Fig. 15

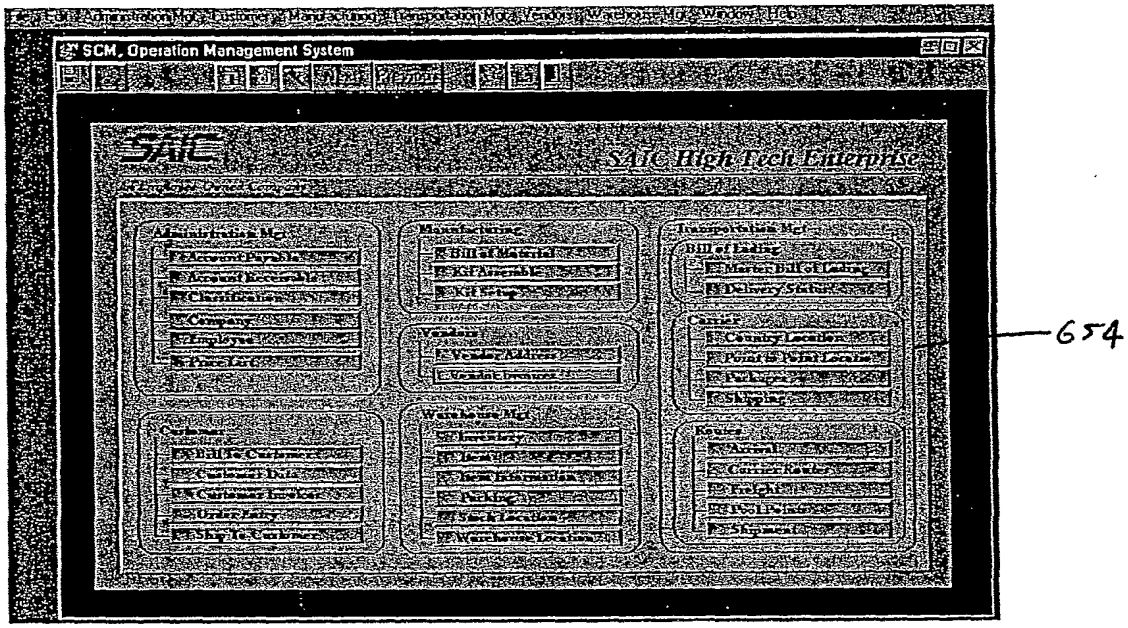

SCM, Operation Management System
SAIC High Tech Enterprise
654

Fig. 16

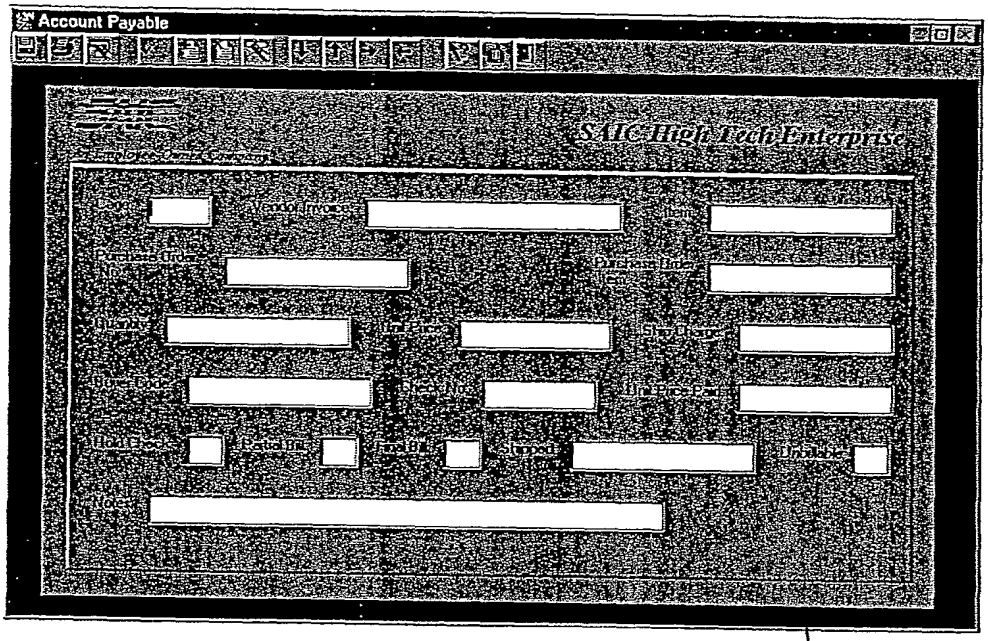
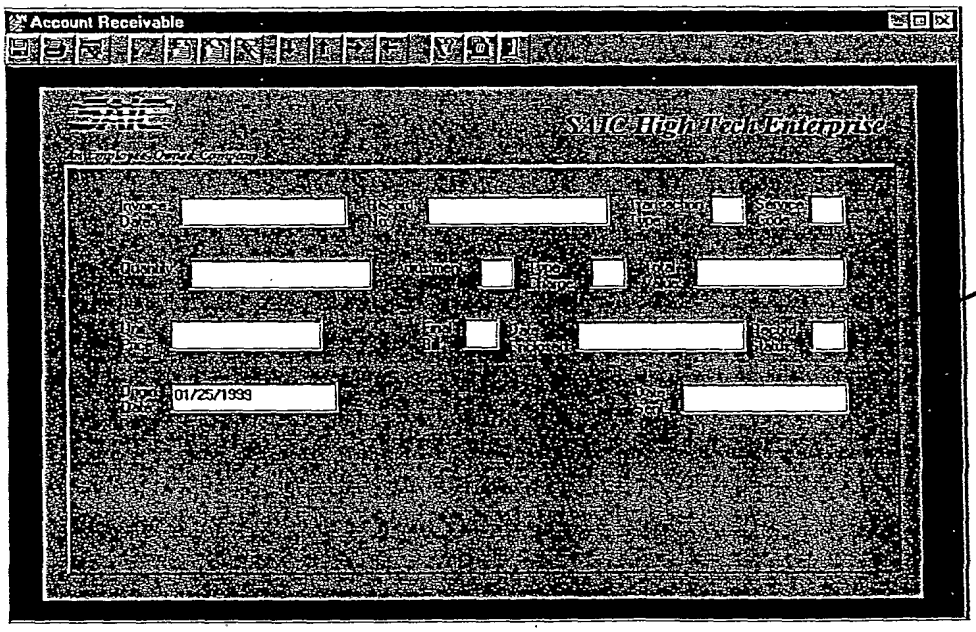


Fig. 17

656



658

Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/12986

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06F 17/30, 17/60
US CL : 705/7,8,10,26,35; 707/10,102

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 705/7,8,10,26,35; 707/10,102

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 6,151,582 A (HUANG et al) 21 November 2000 (21.11.2000), column 1 lines 45-65, column 4 lines 35-60.	1
Y,P	Fu et al, Multi-agent Enable Modeling and Simulation Towards Collaborative Inventory Management in Supply Chains, Simulations Conference, 2000. Proceedings December 2000, Pages 1763-1771, especially pages 1764-1766.	1
Y,P	Zang et al, The Modeling, Optimization, Planning and Execution of Supply Chain Management in Enterprises Integration Based on ARIS and SAP/R3, Proceedings of the 3rd Congress on Intelligent Control and Automation, June 2000, Pages 1935-1937.	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
31 May 2001 (31.05.2001)

Date of mailing of the international search report
26 JUL 2001

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Facsimile No. (703)305-3230

Authorized officer
John E Breene
Telephone No. (703)305-3900

Form PCT/ISA/210 (second sheet) (July 1998)